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Robusta coffee model: An integrated model for coffee production at a regional scale

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Introduction

Vietnam is the second largest coffee producing nation in the world (~1,650 M metric tons in 2014). The coffee industry is significantly influenced by seasonal climate variations, water shortages, and extreme climatic events, especially drought. Given the expected increase in global coffee demand and potential adverse effects of projected climate variability, the success of the Vietnamese coffee industry depends heavily on capitalising potential opportunities and on minimising the risks along the supply chain.

Advances in seasonal climate forecasts, when integrated with crop production systems, can greatly improve industry preparedness and productivity. We present the progress on the development of the world's first 'Robusta variety' coffee production model, an integrated forecasting system, which aims to provide coffee production estimate based on simulating coffee growth biophysical processes and seasonal climate forecast systems.

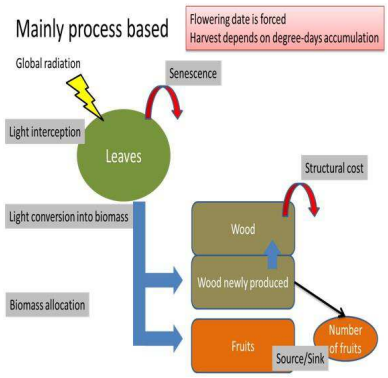
Methodology

The Robusta Biophysical Model

The model simulates the growth of different organs and the phenology of coffee plants at daily time step, based on initial information from the previous season (i.e. harvest date and yield) and meteorological data (min and max temperatures, solar radiation, rainfall).

Solar radiation and temperature are the drivers of growth and development, respectively. Whereas rainfall is used to calculate a drought stress that reduces growth.

Only the impacts of climate are evaluated, i.e. crop management practices (irrigation, fertilization) or pest and diseases are not included.



Coffee Yield Forecasting based on Seasonal Climate Forecasts

The calibration and evaluation of the model were carried out based on historical coffee yields and climate data from three main producing Vietnamese provinces over 2001-2014.

Next, simulations were extended to a 30-yr historical data for analogue analysis and as a basis for coffee yield forecasting using seasonal climate forecasts.

Results

- Two consecutive phases (vegetative and reproductive) considered in each season
- Number of fruit set determined by the growth of branches from the previous year and until the end of the vegetative phase of the current year

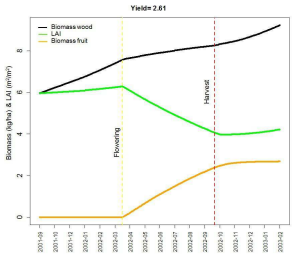
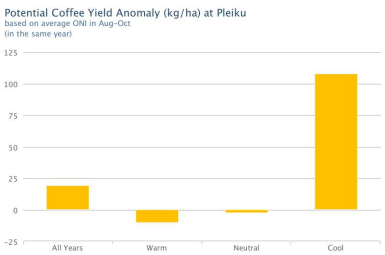


Figure 1: Interannual variability satisfactorily captured.



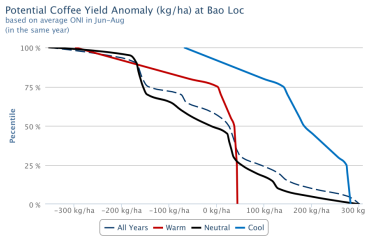
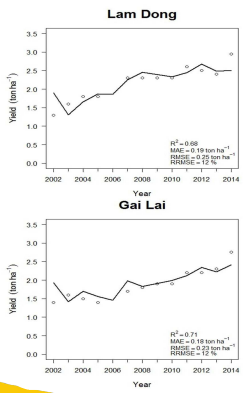


Figure 3: Outlooks of coffee yields for the next season based on key climate drivers, e.g. SOI phases, Oceanic El Niño index.



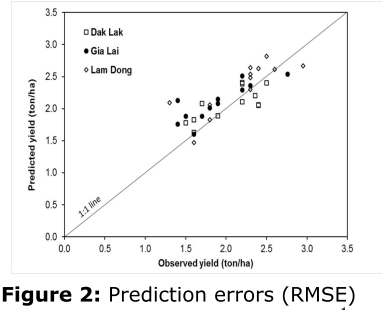


Figure 2: Prediction errors (RMSE) ranging from 0.23 to 0.25 ton ha^{-1} (that is, 12% of error).

Conclusion

While additional work is yet to be done, the preliminary results are promising. Seasonal climate and crop forecasting can offer substantial benefits to coffee growers and industry through increased profitability, better logistical arrangements and preparedness for extreme events such as floods and droughts.

Further refinement and improvement of the parametrization are ongoing to provide more reliable and comprehensive outputs at different lead times.

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